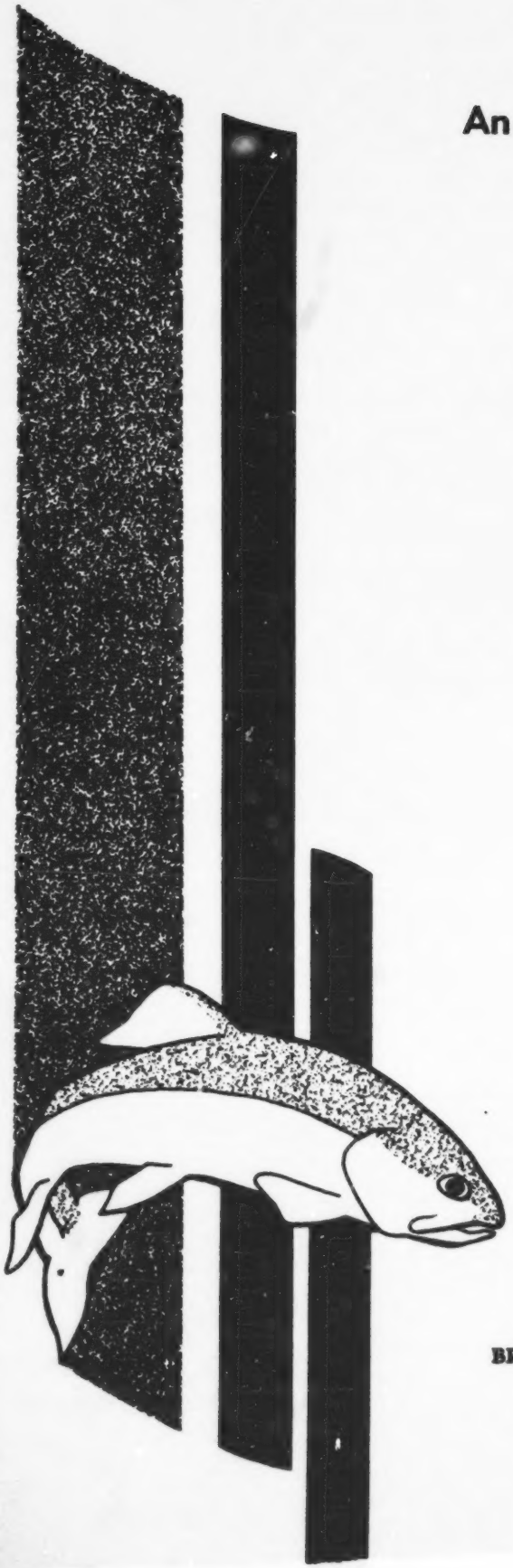

An Evaluation of the Catchable Trout Program in Lakes near Vancouver, British Columbia

by

Eric A. Parkinson

Province of British Columbia

Ministry of Environment

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AN EVALUATION OF THE CATCHABLE TROUT PROGRAM IN LAKES NEAR VANCOUVER, BRITISH COLUMBIA

by

Eric A. Parkinson[1]

[1]Ministry of Environment, Fisheries Branch, 2374 Main Mall, University of British Columbia, Vancouver, B.C., V6T 1W5

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ABSTRACT

Parkinson, E. A. 1985. An evaluation of the catchable trout program in lakes near Vancouver, British Columbia. Fisheries Management Report No. 80, 23 p.

The success of a catchable trout program on seven lakes near Vancouver is described in terms of effort generated, success rates in the fishery and total catch. The effort generated by this was sufficient to produce a positive cost/benefit ratio when the value of an angler day exceeds $7.80. Cost/benefit ratios were much lower than conventional yearling stocking programs. The average CPUE for this program (.22 fish/hr, .61 fish/day) was somewhat lower than for conventional stocking programs in this area. Total catch on the seven lakes accounted for 59% of the fish stocked. Anglers on these lakes were less experienced than average and the proportion of individuals < 16 and > 65 years of age was higher than that determined by the national sportfishing survey.

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INTRODUCTION

Freshwater angling opportunities in the vicinity of metropolitan Vancouver and Victoria are limited because of the low productivity in nearby lakes and streams, and a high angling demand which has resulted in the overexploitation of local fish populations. Catchable trout, planted at a size of about 150 g, are one of a number of alternatives being used to improve angling opportunities in this area. Since catchable trout do not have to grow or survive year round, sites that are unsuitable for natural trout production can be used to provide angling opportunities for individuals who are unable or unwilling to travel to the more productive lakes in the interior of the province. With the completion of the Fraser Valley hatchery at Abbotsford, the Fish and Wildlife Branch initiated a catchable trout program which in 1978 involved 87,000 fish weighing 13,125 kg. In terms of weight, this was about 73% of the 1978 production of the Fraser Valley hatchery and 28% of the provincial total.

Catchable trout programs have generally been successful in other jurisdictions but because of the importance of these fish in the provincial hatchery program, an evaluation under local conditions was needed. In 1979 a creel census was conducted on seven small catchable trout lakes in the Vancouver area to determine angler success, total effort and total catch. The target population for the catchable trout program consists of individuals who cannot easily utilize other fishing opportunities which can be provided at a more reasonable cost. A secondary objective was to determine the proportion of anglers belonging to this target group. Anglers were characterized by factors such as age and experience and then subjectively judged to be part of or not part of the target population. A short review of creel census methodology has been included.

CREEL CENSUS METHODOLOGY

A sampling schedule using a stratified random design with non-uniform probability sampling such as that of Malvestuto et al. (1978) is probably the best procedure to use in creel census. Stratified designs are essential because catch and effort vary considerably through time. Typical strata include time of day, day of the week and month of the year. The introduction of strata can never increase the variance on the mean and can substantially decrease the variance if there are large differences between the means in different strata. In creel censuses the variance on the estimate of effort will be reduced by a weekday-holiday stratification because more people fish on holidays. The variance of the catch per unit effort estimate, however, is usually unaffected by this stratification.

A random design implies that sampling times are picked at random within each strata. In a practical sense, it is sometimes difficult to sample randomly. Random sampling implies

a preset but random schedule which is difficult for a full time creel census clerk to follow. If one clerk is used to census two lakes, then random sampling on one will preclude random sampling on the other. Systematic sampling eliminates these problems and is often equivalent to random sampling. The only serious problem in systematic sampling is periodic populations which have periods in harmony with that of the systematic sampling schedule. In creel census, for example, more people may fish on Fridays and Mondays than on other weekdays. A sampling schedule for the weekday strata with a period of 5 days would provide an incorrect estimate of the mean and variance of the weekday effort during a month. This problem can be solved by including each weekday an equal number of times during each month. Scheaffer et al. (1979) discuss systematic sampling and conclude that although there are problems with this technique, they are not serious enough to preclude its use if some precautions are taken.

Non-uniform probability sampling implies that some strata are sampled more extensively (i.e. at a higher probability) than others. Sampling probabilities are generally designed to be proportional to the expected amount of fishing effort in each strata. The objective is to reduce the variance of the mean in heavily used strata by increasing the number of sample points (i.e. sample size) in these strata. In this way, the variance of the total can be reduced below that expected from simple stratified sampling.

Sampling problems are also encountered in conducting interviews with anglers to determine catch, catch per unit effort (CPUE) and various characteristics (e.g. ages) of the angler population. Random sampling is preferable but if there are large numbers of people on the lake, picking those to be interviewed can be a formidable problem. Systematic sampling, in the form of picking every nth person, is again employed and generally presents no serious problems. A second problem is the biases that may occur in trying to estimate the means of various parameters. When sampling catch or CPUE, a random sample of the individuals actually fishing at the time is an appropriate, unbiased sample. In estimating other parameters (e.g. age composition of anglers), however, a more appropriate sample may be a random sample of individuals who fish the lake. A random sample of individuals actually fishing at any one time is biased in favor of those individuals who make longer trips (length of stay bias) and those who fish more days per year (frequency of use bias). Sinclair and Morley (1975) discuss this problem and suggest a correction whereby responses are weighted by the inverse of the total fishing effort expended by the individual, but this correction can only be used if the estimates of yearly fishing effort provided by individual anglers are accurate. Finally, in measuring catch and CPUE, it is desirable (as discussed by Robson 1960, 1961) that sampling of anglers takes place at the end of a trip because of possible differences in fishing success between complete and incomplete trips. This bias is often ignored in favor of the more efficient roving creel

census in which the checker interviews fishermen while they are fishing.

STUDY LAKES

The seven lakes were chosen to represent a range in size and distance from population centers. Brohm, Browning and Stanley are all very close to a main highway but are between 10 and 25 km from the nearest town (Squamish) and 50 to 85 km from Vancouver (Fig. 1). Surrey Pond is in a rural section of Surrey, a suburb of Vancouver and is less than 10 km from a number of housing subdivisions. The other three lakes are all less than 1 km from large housing subdivisions. In addition, angling on Browning and Como lakes was restricted to persons aged 16 and under, and 65 and over. Some of the other characteristics of the lakes are summarized in Table 1.

Table 1. Physical and chemical characteristics of the study lakes. Theoretical yield is calculated by the method of Ryder et al. (1974).

Lake	Area (ha.)	Max Depth (m)	Mean Depth (m)	Maximum Epilimnion Temp.	TDS (mg/l)	Theoretical Yield (kg/yr)
Wilderness						
Brohm	12.7	24	11	18 C	17	63
Browning	2.6	10	4.2	17 C	50	21
Stanley	1.0	5	2.7	18 C	22	7
Suburban						
Como	4.0	4	2.0	25 C	58	40
Lafarge	3.0	7	3.0	22 C	64	30
Mill	17.3	13	4.3	20 C	48	138
Surrey	10.0	3	1.8	26 C	50	100

Only Brohm Lake supports a sparse natural trout population. Natural populations are absent in the other six, probably because of a lack of spawning habitat. Potential fish production from stocked fry or fingerlings in these lakes are very low. Potential angling yield from production by natural stocks (calculated by the method of Ryder et al. (1974)) was only 9% of the total weight of catchable trout stocked in these lakes in 1979. Summer temperatures are not high enough to be lethal and the duration of ice cover is too short to induce winterkill. Oxygen concentrations are adequate for trout year round.

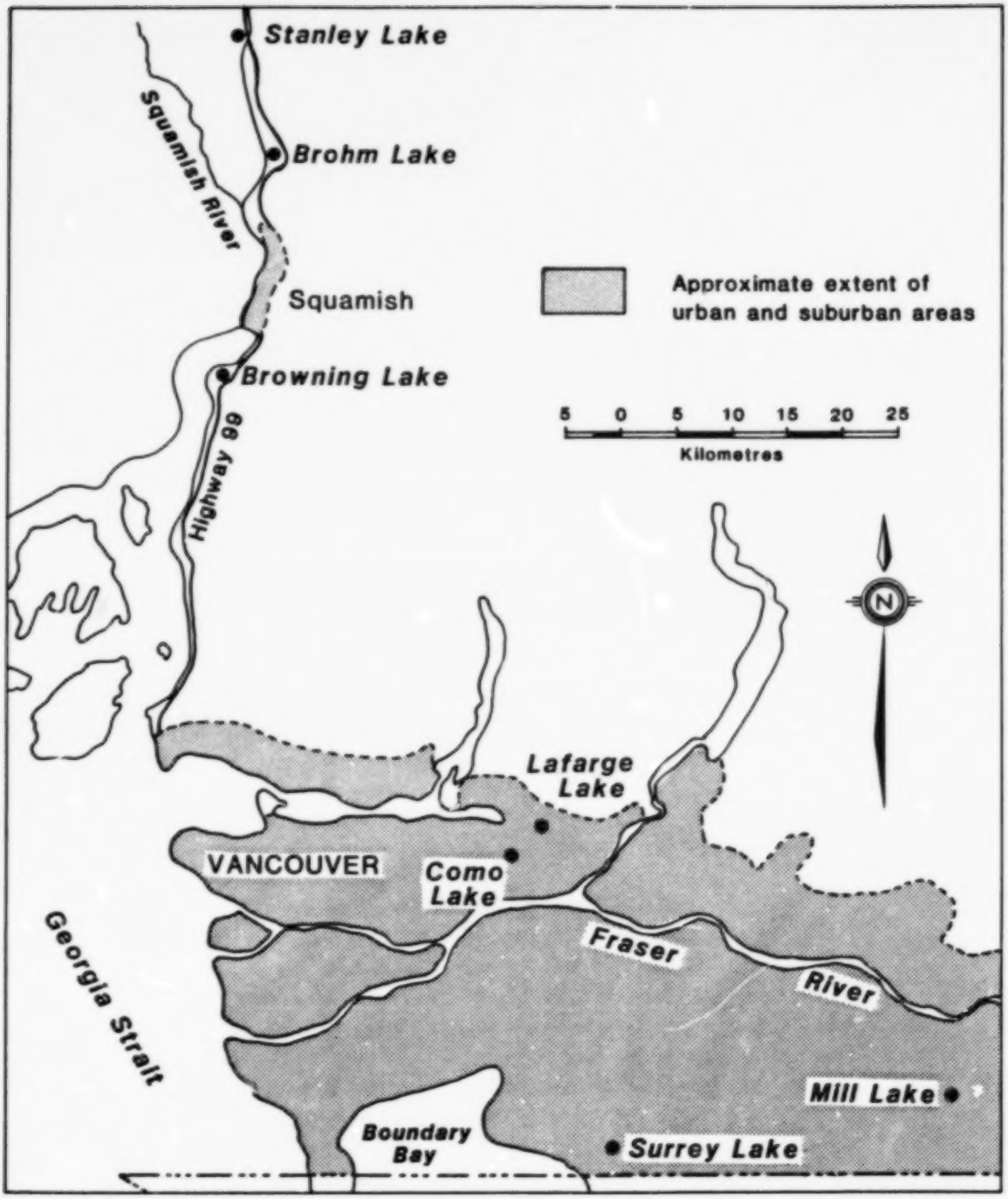

Fig. 1. Map of study area.

METHODS

The seven lakes were part of a regular stocking program and were stocked at the times detailed in Table 2. The fish are all progeny of a domestic brood stock maintained at the provincial fish hatchery at Abbotsford, British Columbia.

Table 2. Size, number and date of release of fish stock in the seven study lakes.

	Spring 1979			Fall 1979		
Lake	Release Date	Size (gr.)	Number	Release Date	Size (gr.)	Number
Brohm				Sep 17	145	1500
Browning	Mar 26	240	2000	Sep 17	145	1500
Stanley	May 8	210	2000			
Como	Jan 15	220	2000	Sep 10	135	1000
				Oct 22	190	2000
Lafarge	Mar 19	225	2000	Sep 10	135	2000
				Oct 22	190	1000
Mill	Mar 16	215	1000	Sep 11	135	1500
				Oct 24	230	1500
Surrey	Mar 15	215	2000	Sep 27	145	1400
				Oct 24	190	1600

The general design of the program was a stratified systematic design (Scheaffer et al. 1979). Sampling was stratified by time period (morning or afternoon), day type (holiday or weekday) and month of the year. The sampling schedule was set up so that mornings and afternoons were sampled equally, holidays and weekdays were sampled in a 2:5 ratio with each day of the week represented equally (ie. uniform probability sampling) and months were sampled in proportion to the effort expected (ie. non-uniform probability sampling).

Sampling on each lake was comprised of two components, counts and interviews. Since the lakes were small, complete instantaneous counts could be made every two hours. The total effort for a time period, expressed in angler hours, was twice the total of the counts made during that period. Every two hours immediately following the count, the interviewer circled the lake once and interviewed anglers as they were encountered. Generally, there was sufficient time to interview every angler before the next count had to be made and, therefore, each angler was interviewed every two hours. In repeat interviews, the only questions asked were those concerning the number of fish caught and the time since the last interview. A CPUE estimate for each strata was generated from the interview data by dividing the

total catch by the total effort from the interviews. Total catch for a strata was the product of the CPUE and effort for the strata. The total catch for the lake was the sum of the catches for each strata.

Although the lakes are small, there are generally a number of access points on each one. This, and the lengthy nature of the questionnaire, made a roving creel census of the predominantly shoreline anglers more practical than the more desirable exit census. Interviews and counts were made on a regular basis on Browning, Como, Lafarge, Mill and Surrey lakes in May, June, September, October and November 1979; on Stanley Lake in May and June 1979, and on Brohm Lake between September and November 1979. Censuses were performed outside these time periods on a sporadic basis to confirm that most angling took place during the regular census.

RESULTS

CATCH PER UNIT EFFORT

Catch per unit effort provided an indication of the quality of angling and, as such, includes both killed and released fish. The jackknife estimator (see Smith, 1980) was used to estimate the mean and variance of the ratio of catch to effort for each lake and month. Catch per unit effort peaked in spring and fall in all lakes and was at a minimum in the summer and, less clearly, in the winter (Fig. 2). This is probably due to the fact that fish were placed in these lakes in spring and fall, but a depression in CPUE during summer is also common in lakes not stocked with catchable trout. Fish were stocked up to a month and a half prior to the start of the census in spring, so it is not surprising that CPUE is generally lower in the spring than in the fall.

On a daily basis, there is some indication that CPUE declines with time since the last stocking (Fig. 3), but the correlations are weak. This is somewhat surprising since the total catch calculations show that fish are removed quite rapidly. Much of the residual variation in the figure 3 correlations appear to be due to occasional very high CPUE's (up to 10 fish/hr) of individual anglers.

EFFORT

Although counts varied considerably over the course of the day, morning and afternoon counts did not differ significantly from each other because of the almost symmetrical shape of the daily effort curve (Fig. 4). The time period stratification was, therefore, removed and morning and afternoon counts were treated as simple half-day counts. The mean and variance of total effort was calculated using standard formulas

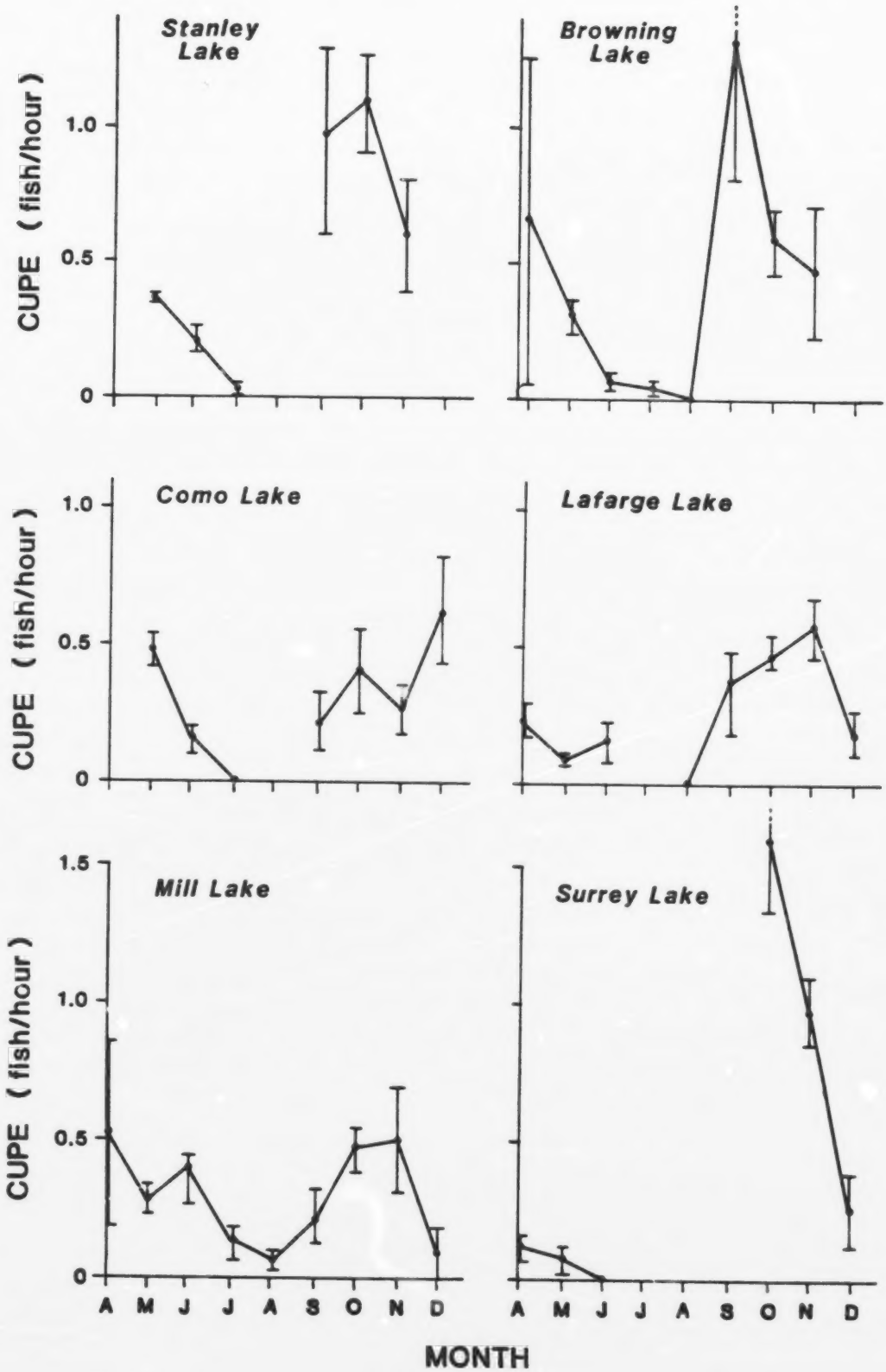

Fig. 2. Seasonal catch per unit effort on the seven study lakes. Bars represent 95% confidence limits calculated from the jackknife estimation.

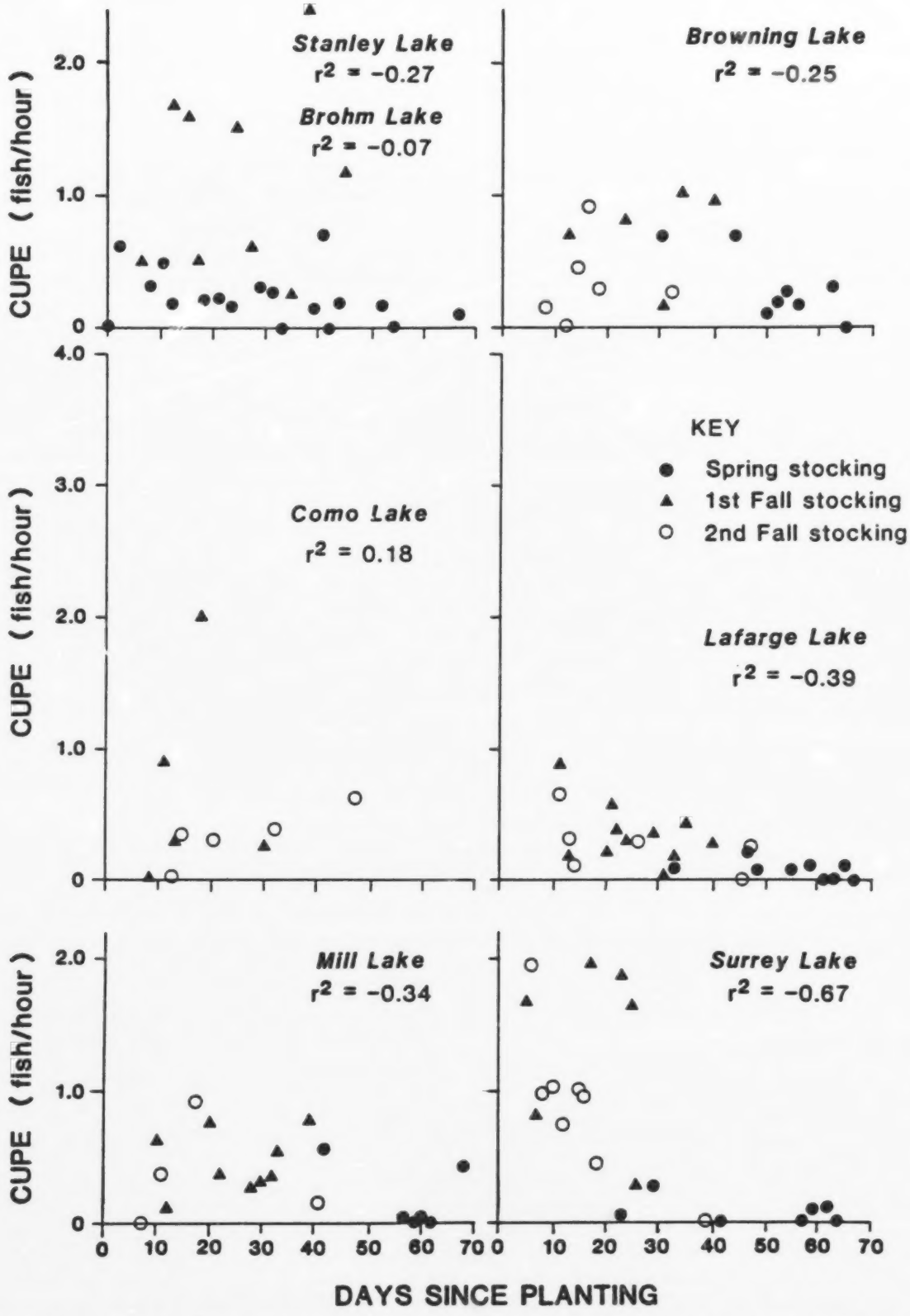

Fig. 3. Daily CPUE vs time since stocking. Days with less than 5 interviews are excluded. Correlation coefficients, included in the upper right hand corner of each graph, were significant at the a = .05 level for Lafarge and Surrey lakes.

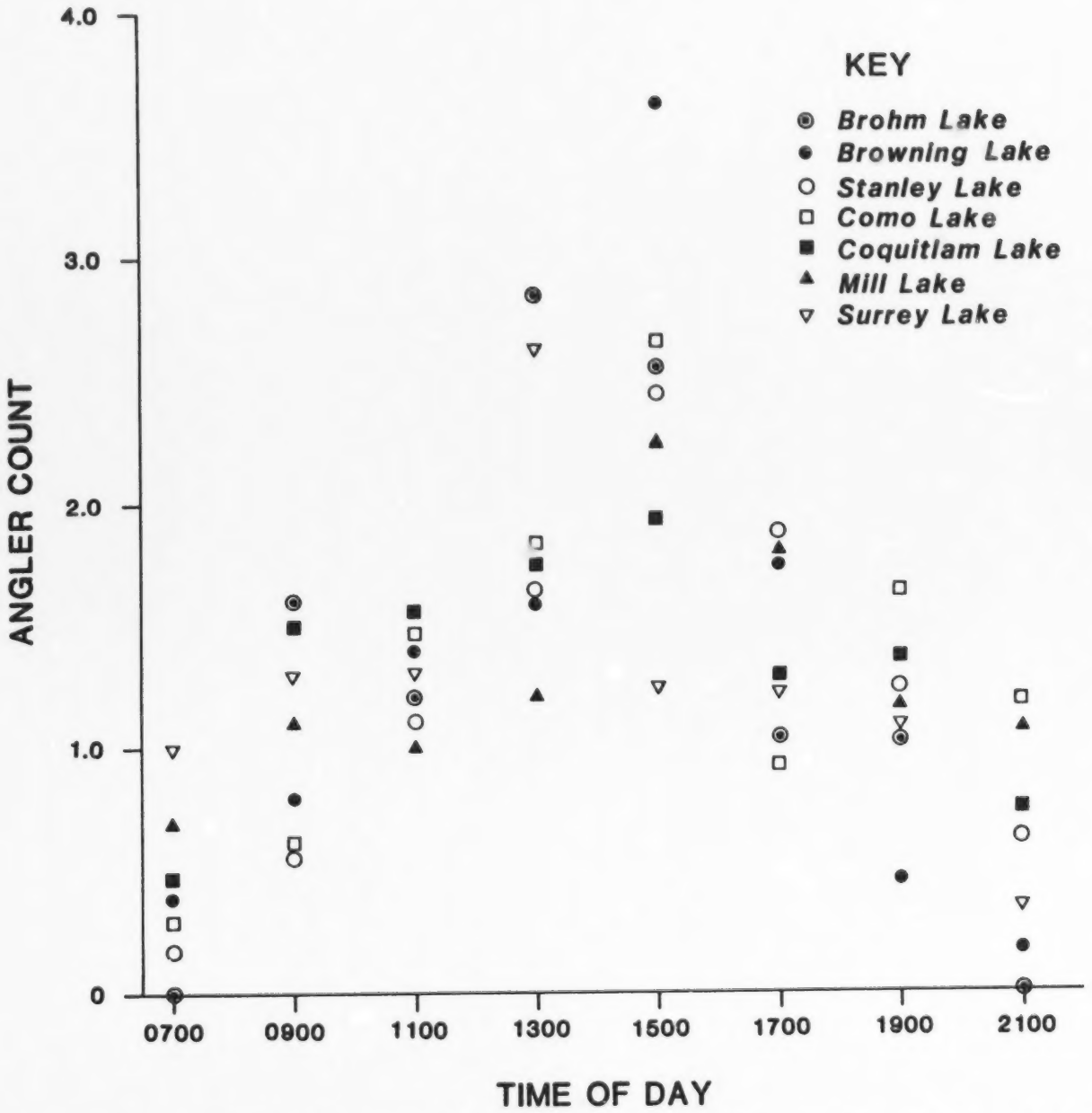

Fig. 4. Daily distribution effort on the seven study lakes averaged over all holidays.

for stratified random sampling (e.g. Scheaffer et al. 1979). Because each day of the week is sampled uniformly, biases in the mean due to systematic sampling should be minimal.

Trends in monthly effort generally followed those for CPUE. Effort was generally much higher during the spring months. From a limited number of counts it appears the effort was high in April on three of the lakes (Fig. 5) and dropped rapidly in May and June. In most lakes, the midsummer minimum was very pronounced with essentially no effort expended in August. In Browning Lake, however, some effort was still expended despite a CPUE of zero in about forty interviews made in August. In Mill Lake, effort dropped with decreasing CPUE in the summer but did not increase in response to large increases in CPUE during September. Effort was lower in the autumn than in the spring on most lakes despite a generally higher CPUE. The winter minimum was not as pronounced as the summer minimum. Winter CPUE was not as low as that in summer and anglers continued to fish on warmer, sunnier days in December.

The total effort for the lake was the sum of the efforts for each month. For months in which the number of sampling days was too small to calculate a variance, the mean coefficient of variation for counts in other months was used to generate a variance for monthly effort and to calculate confidence limits on the estimate of the total effort expended in the April to December period (Table 3). Since a large fraction of the effort on some lakes was expended during April, confidence limits on total effort estimates are only approximations.

Table 3. Total effort mean CPUE, total catch and present return of stocked fish in the seven study lakes between April and September. The average angler day was equal to 2.7 hours.

	Total Effort ± 1 S.E. (Anglers hrs)	Effort/Fish Stocked (hrs/fish)	Mean CPUE (fish/hr)	Total Catch	Percent Return Spring	Percent Return Fall
Wilderness						
Brohm	1500 ± 370	1.0	.6	900		57%
Browning	11000 ± 4000	3.1	.21	2300	53%	82%
Stanley	5800 ± 1570	2.9	.16	900	46%	
Suburban						
Como	7000 ± 1600	1.2	.29	2000	78%	14%
Lafarge	14900 ± 1600	3.0	.17	2500	39%	57%
Mill	15000 ± 1200	3.8	.22	3300	246%	28%
Surrey	14500 ± 7600	2.9	.24	3500	26%	102%

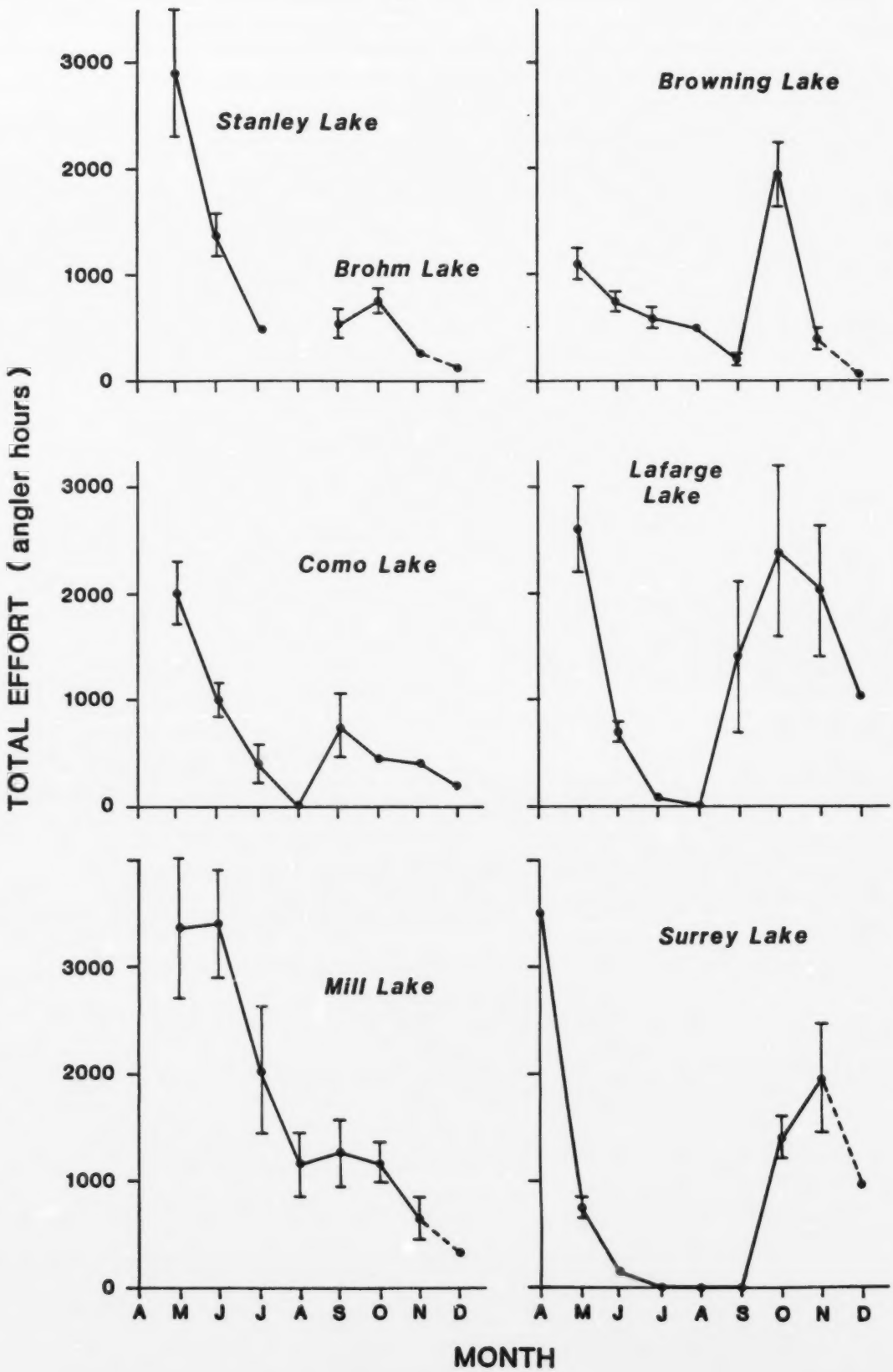

Fig. 5. Seasonal variation in effort on the seven study lakes. Bars represent 95% confidence limits.

The amount of effort generated per fish stocked was similar on all lakes except for Como and Brohm where effort/fish was considerably lower (Table 3). Brohm and Stanley lakes are similar with respect to regulations and the distance to population centers but Stanley has a campsite which is used extensively by anglers. In addition, Brohm was censused only in the fall when effort tends to be low on all lakes. Como Lake is very close to Lafarge Lake but Como has an under 16/over 65 age restriction which may have resulted in a reduction in angler effort. Very few families fished suburban Como Lake. In contrast, Browning Lake, the only other lake with an age restriction, is a wilderness lake and was heavily used by families who drove more than 50 km to reach it.

TOTAL CATCH AND RETURN

The total harvest in each lake during the census period was calculated on a monthly basis as the product of the total effort and the mean CPUE (including only killed fish) for the month (Fig. 6). No attempt was made to determine the error in this estimate because the error of the product of two dependent quantities is difficult to calculate. Total harvest was used to estimate the proportion of stocked fish returned to the creel. Returns were calculated separately for spring and fall stockings. The high variances for the effort and CPUE estimates are reflected in the large amount of variability in the estimated percent returns including some which are greater than 100% (Table 3). In Mill Lake, which received only 1000 fish in the spring of 1979, the survivors of a larger stocking which were lightly fished the previous fall may have contributed to spring returns which were greater than 100%. Because of the erratic nature of the fisheries and the large errors in both effort and CPUE estimates, the time required to remove various percentages of fish was not compared in the different lakes. Total harvest estimates and, in some cases, a declining CPUE both indicate that removal is fairly rapid with most fish being removed within two months. Overall, a total of 26,000 fish were stocked and 15,300 were harvested in the seven lakes giving an average return rate to the creel of 59%.

THE CHARACTERIZATION OF ANGLERS

An interview circuit of each lake was made every two hours and anglers who had been previously interviewed were not characterized a second time; i.e. sampling was done without replacement. With this sampling design, samples are biased in favor of individuals who fish more days per year (frequency of use bias) and more than two hours a day (length of stay bias). This bias is, however, considerably less than that encountered in an uncorrected sampling with replacement. Since over 75% of anglers fish more than two hours, the length of stay bias is not serious in this case. When sampling is done without replacement,

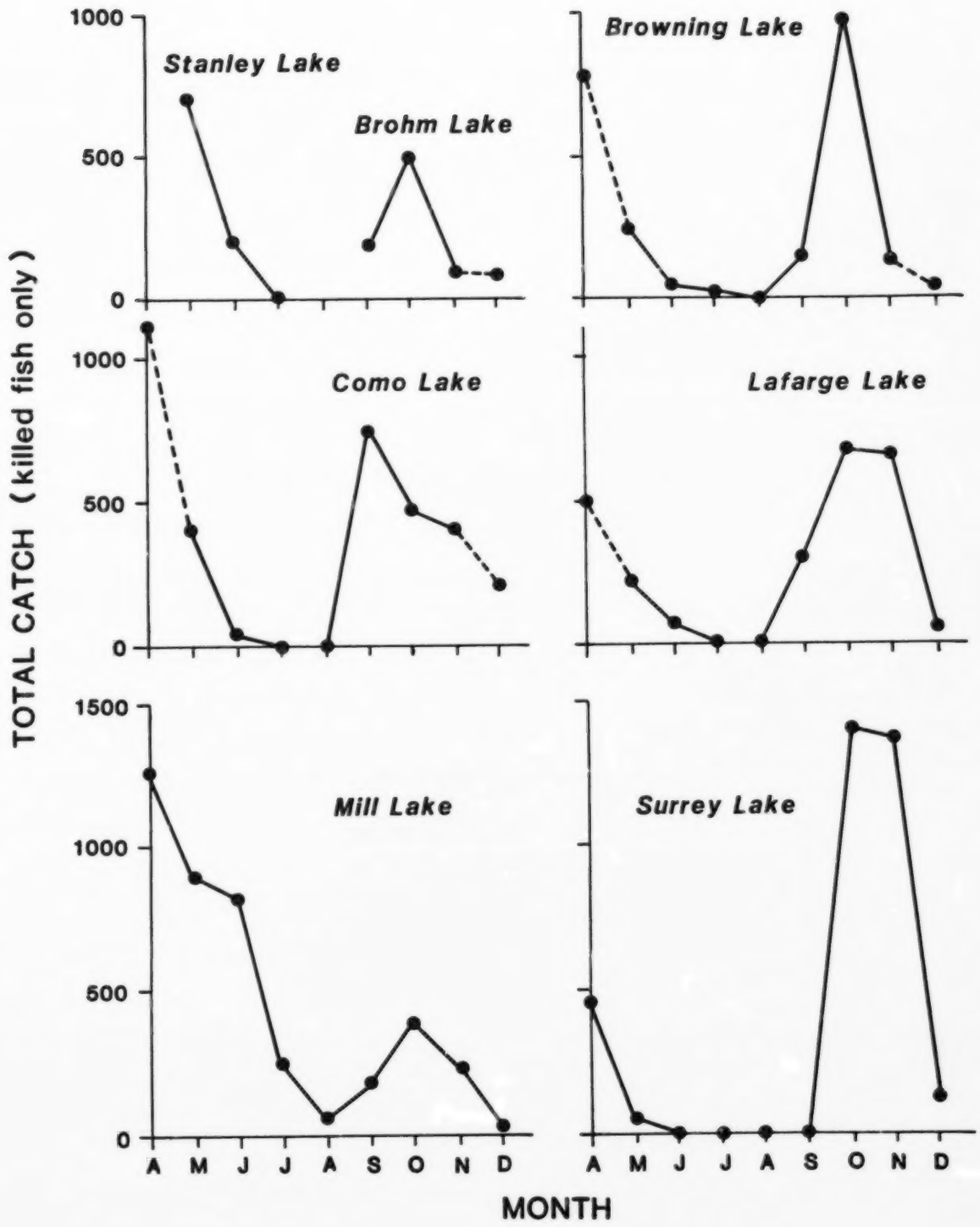

Fig. 6. Seasonal variation in catch on the seven study lakes.

there is no way to correct for length of stay bias and, therefore, the biased results are reported here.

The main objective of the angler characterization was to determine the proportion of anglers belonging to a socio-economic target group consisting of inexperienced anglers and people such as children who are unable to travel long distances in order to fish.

If inexperienced anglers are defined as those who either fish less than 5 days per year or have fished for less than 2 years, then a minority of the fishermen on these lakes could be termed inexperienced anglers (Fig. 7). The frequency distribution of days per year is relatively flat but the years of experience graph drops rapidly, implying that the inexperienced/experienced percentages are sensitive to the precise choice of the cutoff value of this parameter (i.e. 2 years in this case) (Fig. 8). Inexperienced fishermen may be a poor target group since CPUE of individuals is not correlated with either days per year fishing (r^2 = .019) or years of experience (r^2 = .10).

Identifying anglers who find travel to more distant opportunities impractical is more difficult since it is usually a matter of degree of difficulty rather than impossibility. For lack of better criteria, I decided that persons under 16 or over 65 and families with children are those who have the greatest practical difficulty in traveling. I recognize that this is a subjective assessment and that there are individuals over 65 who have the means to travel extensively while some middle aged people do not. Age distribution fell into 3 distinct patterns. On Stanley and Brohm lakes the distribution peaked in 17-60 age classes but on Mill, Surrey and Lafarge lakes the distribution was almost flat (Fig. 9). In Browning and Como lakes, because of special regulations, 17-60 year old anglers were almost absent and virtually all anglers were in the target group. The contention that middle-aged anglers are able to travel to fishing opportunities is supported by the fact that they are the predominant group on the lakes (Brohm and Stanley) which are farthest from major population centers.

The percentage of anglers in family groups (at least one adult plus children) was similar on all lakes, except Browning where it was nearly twice that on other lakes (Fig. 7). Travel by families does not appear to be inhibited by the range of distances covered in this study since lakes which are farther from population centers do not have fewer families on them.

If the age and family target groups are combined, then an average of 58% of anglers are in the target group on lakes without age restrictions (Fig. 7). If the inexperienced target group is combined with the age family target group, then an average of 68% of anglers are in the target group on lakes without age restrictions (Fig. 7).

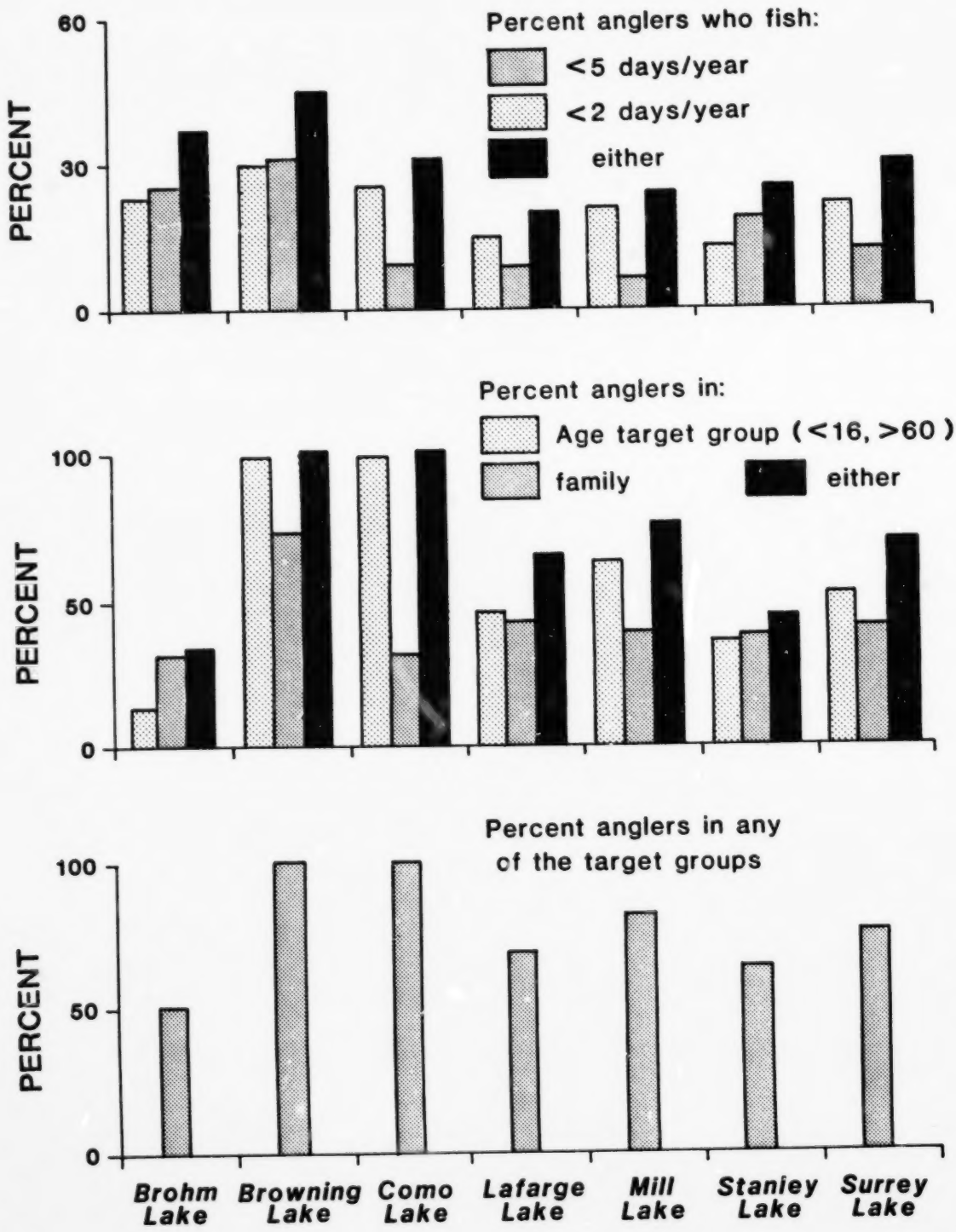

Fig. 7. Percentage of interviewed anglers in various target groups on the seven study lakes.

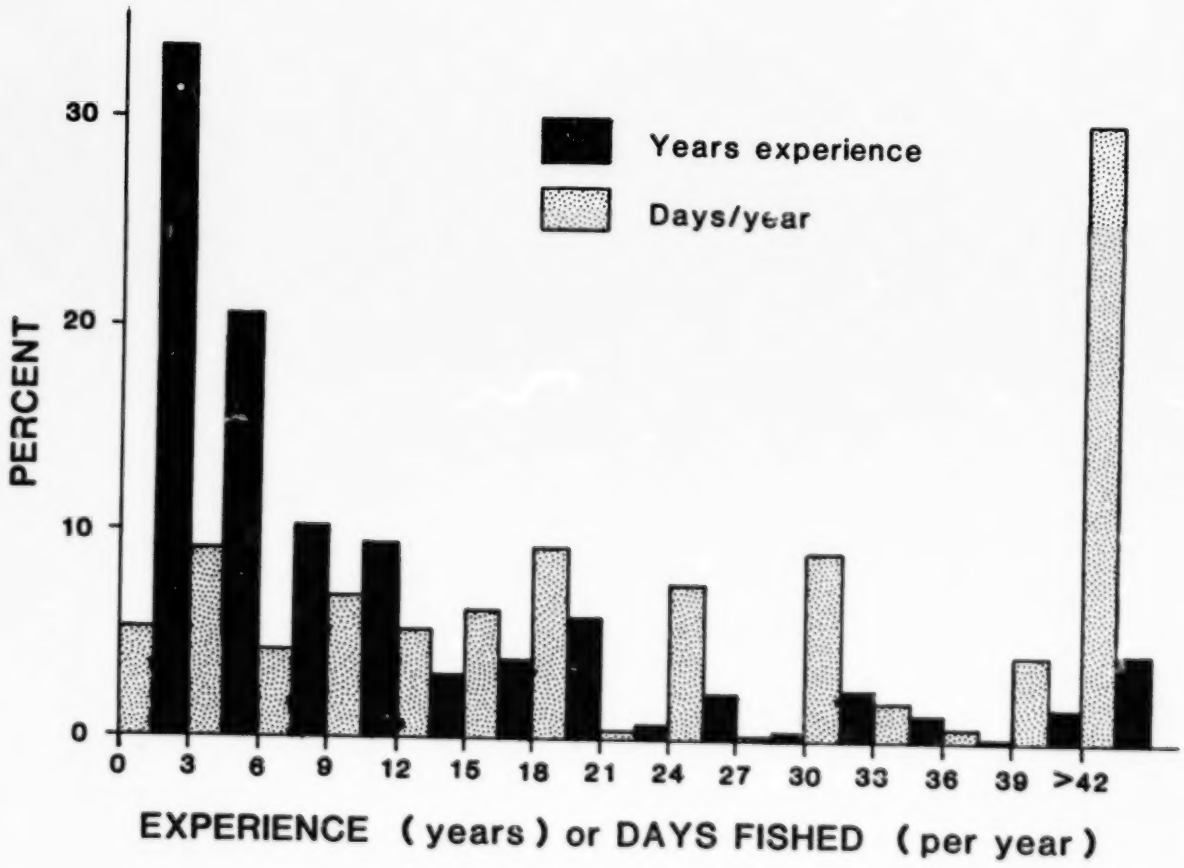

Fig. 8. Frequency distribution of years of experience and days fished per year of interviewed anglers on all seven study lake combined.

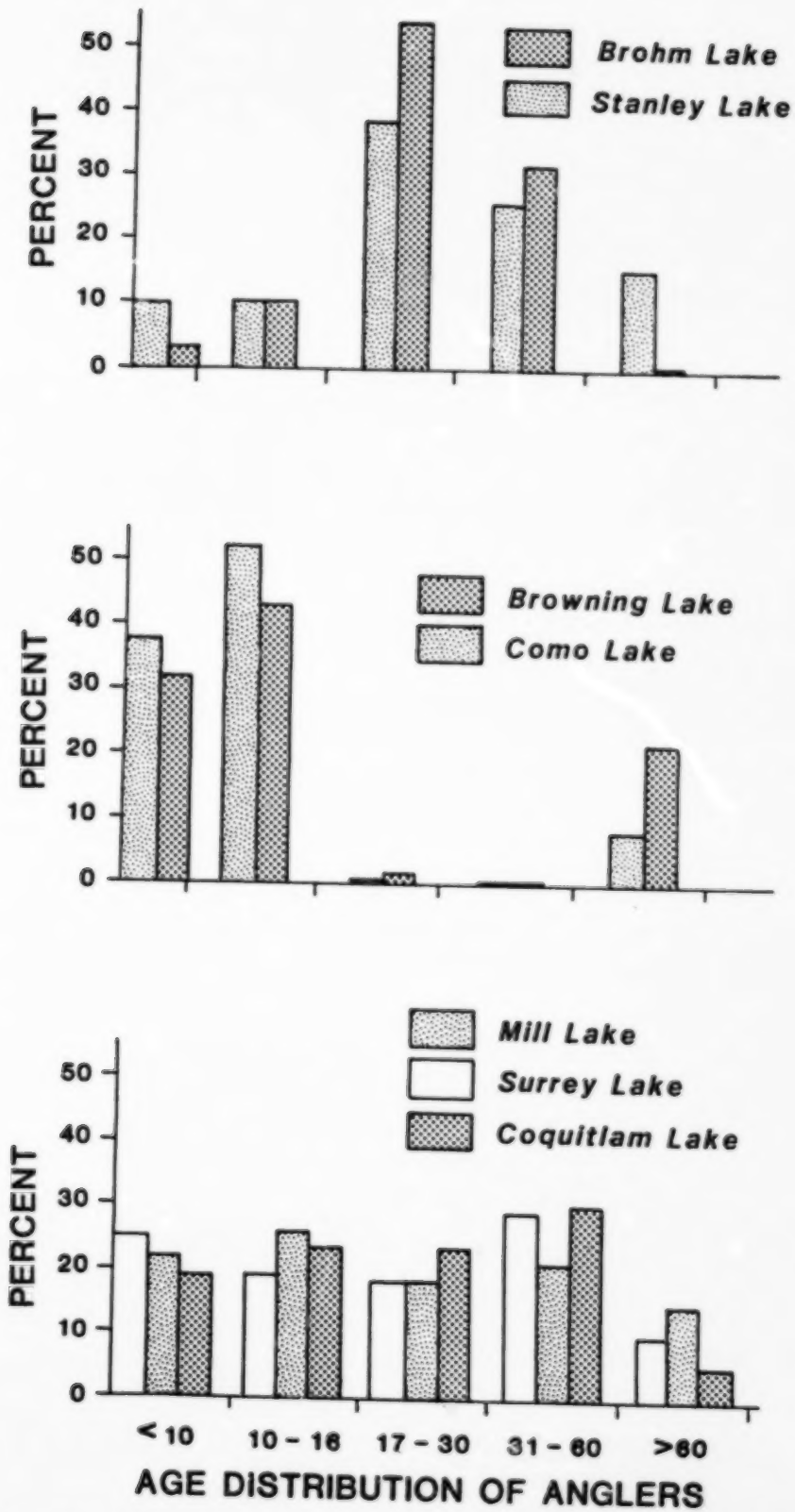

Fig. 9. Age class distribution on the seven study lakes.

The characteristics of urban anglers can also be compared to the average angler using data from the national sportfishing survey. There are slightly more older (over 60) anglers on urban lakes (12.5% vs 9.7%) but this difference is probably not significant. Juveniles (under 16) are much more heavily represented on urban lakes (48.0% vs 21.3%). If age restricted lakes are not included the percentage of older anglers rises to 14.5 and the percentage of juveniles drops to 37.3. Males represent a higher than average proportion of urban anglers (85.4% vs 74.5%). Only 66% of urban anglers had more than 2 years of experience, whereas 85% of B. C. anglers had more than 2 years of experience. In general, these comparisons support the contention that the urban catchable trout program has a higher than average participation by anglers in the target group.

It was impossible to determine the distribution of catch among anglers from the interview data but anglers were asked how many days per year they fished on the study lakes. From this data it was calculated that over all the lakes, an average of 12% of the anglers exerted 50% of the total effort. Anglers who fish more days per year are, by definition, more experienced and do not tend to be in family groups or in the target age classes.

DISCUSSION

Although they are relatively new to British Columbia, catchable trout fisheries have a long history in the more developed areas of North America. In California, for example, catchable trout stocking began in the late 1940's and by 1962 seven million were stocked yearly (Butler and Borgeson 1965). Many agencies have evaluated their programs but, because these evaluations are usually not formally published, they are frequently unavailable.

The total return to creel of catchable trout stocked in small lakes is usually very high. In the most complete study, total returns of catchable rainbow in seven California lakes averaged 83% (Butler and Borgeson 1965). Returns from lower Sardine Lake, a 48-acre alpine lake in California, were 75% for spring planted rainbow and 75-81% for spring planted brown trout (Boles and Borgeson 1966). Fall plantings had somewhat lower return rates. Similar results are reported by Shetter (1944) for brook trout in Michigan lakes by Forshage (1975) for rainbow in the tailwater of a Texas reservoir and by McAfee (1980) for trout in Colorado reservoirs.

Total returns were lower and showed considerable variability in this study. Most of this variation is probably due to errors in CPUE and effort estimates. In Browning, Lafarge and Surrey lakes, a large portion of the effort appeared to be expended at a time (April) when little censusing was done and these estimates of returns are particularly suspect. Wild fish

probably contributed to the returns in Brohm Lake. Survivors from stocking done the previous fall may have contributed to spring returns especially in lakes such as Mill Lake where fishing effort in the fall appears to be light and spring returns are > 100%. Attempts to use fin erosion and scale patterns to determine how long fish had been in the lake proved to be inconclusive.

Fish are typically removed rapidly after stocking in catchable trout fisheries. Fifty percent were removed within an average of 6.6 days in California lakes (Butler and Borgeson 1965), while Shetter (1944) found that over 90% can be caught on opening day in some lakes. In three small Oregon lakes returns ranged from 50% in a single day to 76% over an 8-day period (J. Griggs, pers. comm.). In Washington it is not uncommon to have 40-50% of a catchable plant harvested on opening day (Jim DeShazo, pers. comm.). The lakes in this study do not fit this pattern. CPUE's during the first ten days following a plant are not unusually high in any of the lakes and the total catch data accounts for most of the fish stocked in each lake. This implies that large numbers of fish were not removed immediately following a plant. The reasons for this difference between these lakes and results reported elsewhere are not obvious. The number of fish planted per acre covers a wide range in most studies and the B.C. lakes are not unusually high or low. CPUE's are difficult to compare but the value of approximately .5 fish/hr for the B. C. lakes in the days following the plant is typical. The most probable cause for the difference is the presence of a large pulse of effort on lakes with a long history of catchable trout planting which is absent on the B. C. lakes. This hypothesis cannot be adequately tested using the available data. Another creel census 5 or 10 years later could be used to determine if effort has become more concentrated in the days immediately following planting.

Mean CPUE (.61 fish/day) on the seven study lakes was somewhat lower than the mean CPUE (.87 fish/day) (A. Facchin, pers. comm.) on 10 other lakes in the region which contained either natural stocks or were stocked with hatchery yearlings weighing ~10 g. The range of CPUE on these other 10 lakes was .2 to 1.6 fish/day, and the above difference was not significant.

Seasonal variation in CPUE is probably due mostly to a simple depletion of fish in the weeks following stocking rather than a seasonal change in catchability. Angler harvest, mostly in the first two months after stocking, accounted for essentially all of the fish in lakes which were censused immediately following stocking. Seasonal variation in CPUE in two larger lakes in the interior of British Columbia was minor in comparison to that reported here (Tautz and Peterson 1977; Larkin et al. 1950). Catchable trout are traditionally planted in spring and fall because it is felt that their survival and catchability are highest at this time. There is some evidence that summer releases give poor returns (e.g. Forshage 1975) but in cool

northwestern lakes this may not be the case. Browning Lake, for example, had a maximum surface temperature of 21° C, a maximum hypolimnetic temperature of 13° C and a minimum hypolimnetic oxygen concentration of 7 ppm. These conditions are well within the tolerance range of rainbow trout. Summer releases could be used on an experimental basis in lakes such as Mill and Browning which maintain high water quality and continue to attract anglers, particularly novice anglers, during the summer.

Benefits and costs were compared to B. C.'s conventional hatchery program using the data of Nordstrom et al. (1978). Costs per kilo of fish stocked were assumed to be the same as the most reasonable average cost ($40 per kilo) estimated by Nordstrom et al. because there is no way to determine if catchable trout are cheaper or more expensive than average to produce. Benefits were calculated on a value per angler day basis also using the Nordstrom et al. values of 5, 10 and 15 dollars/day for B. C. resident anglers. All benefits and costs are expressed in terms of 1978 dollars. The value of a resident angler in this region in 1983 dollars was $17.70 calculated on the basis of willingness to pay (Reid, 1984).

Benefit/cost ratios (Table 4) are much lower than a conventional hatchery program in which small fish are stocked in lakes at a low density and grow to catchable size. The main reason for this is that survival to catchable size of conventional hatchery fish is about 50% but the initial size of these fish is only about 5 g as compared to 150 g for catchable trout. Since costs are estimated on a per weight basis, the hatchery costs of a trout stocked at catchable size are much higher than those stocked at smaller sizes. If the benefit/cost ratios in Table 4 are compared, it can be seen that an angler day on a catchable trout lake would have to be worth 7-8 times as much as one on a conventional lake in order to justify catchable trout stocking on a strict economic basis. A small catchable trout program aimed at a specific target group can probably be justified on the basis of providing a variety of fishing opportunities. Between 1978 and 1981 however, an average of 15,000 kg which was 63% of the Fraser Valley Hatchery capacity or 28% of the total provincial capacity was utilized to produce catchable trout.

The attempt at angler characterization was only marginally successful. While the results are quantitative, the interpretation of these results is very subjective. Age, family status and experience were the factors used to delineate the target groups. If the validity of these factors is accepted, then the program appears to be successful in that the majority of individuals using the fishery belonged to one of the target groups. Since 50% of the total effort is exerted by only 12% of the individuals, there is the possibility that much of effort is attributable to individuals not in the target groups. This appears to be so in that anglers who fish more days per year also

Table 4. Benefits and costs of the catchable trout program on seven small lakes near Vancouver, B. C. Costs are assumed to be $40/kilo of fish stocked and benefits are calculated for a range of values per angler day in a manner similar to Nordstrom et al. (1978). Angler days were 2.75 angler hours long. Benefit cost values for the conventional program are from Nordstrom et al. (1978).

		Benefits at various value/angler day		
Lake	Cost	$5	$10	$15
Brohm	8,700	2,700	5,400	8,100
Stanley	16,800	10,600	21,200	31,800
Browning	27,900	19,900	39,800	59,700
Como	38,200	12,700	25,400	38,100
Lafarge	36,400	27,100	54,200	81,300
Mill	30,500	27,200	54,400	81,600
Surrey	37,480	25,700	51,400	77,100
Total	195,980	125,900	251,800	377,700
B/C		.64	1.28	1.93
Conventional Program B/C		5.52	10.02	14.52

tend to have more years of experience and do not tend to be families or in the over 60/under 16 age group.

The seriousness of the bias problem was not recognized initially. The effort estimates are unbiased but CPUE estimates are biased in favor of ardent anglers who fish more days per year. Thus, if ardent anglers had higher CPUE's, CPUE as an indicator of angling quality would, in one sense, be an overestimate. Since in this case CPUE of individuals was unrelated to years of experience or number of days per year fishing, I concluded that this bias was minimal. The bias toward ardent anglers is more serious in the angler characterization results since a small proportion of anglers who are older, single and experienced account for a large proportion of the effort. An attempt was made to reduce bias through sampling without replacement rather than weighting by the reciprocal of the days per year fished (Sinclair and Morley 1975) because the estimates of this quantity given by anglers did not appear to be reliable. As a result of this bias, the angler characterization results cannot be taken at face value.

Special regulations such as those on Como Lake are effective in assuring a high representation of the target group. A reduced total effort may have been a side effect of the age restriction on Como Lake. A nearby lake with no age restriction attracted about twice the effort that Como Lake did. Restrictions can have different effects on different lakes. Most of the individuals on Como Lake, a suburban lake with an age restriction, were under 16 and not in family groups. In contrast, there were many families present on Browning Lake, a lake with age restrictions which was over 10 km from any population center.

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